WHAT IF WE COULD PURIFY AND REUSE OUR WASTE AIRCRAFT HYDRAULIC FLUID?

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INTRODUCTION

The United States Air Force (USAF) spends approximately $30 million per year in the disposal and replacement of used hydraulic fluid. This estimate is based on Tyndall AFB consumption and disposal costs times the number of worldwide Air Force bases with flying missions. Most of this money could be saved if the hydraulic fluid were purified and reused. The Air Force Research Laboratory, Materials and Manufacturing Directorate, Airbase and Environmental Technology Division (AFRL/MLQ), Tyndall AFB, Florida, is sponsoring a project that will enable the Air Force to realize these savings.

Routine USAF aircraft operations generate large quantities of waste hydraulic fluid each year. Through regular use, accumulation of particulate matter and water requires the disposal of the fluid. The Air Force generated a need to evaluate economical equipment and/or processes that would allow the USAF to reuse the contaminated hydraulic fluid (USAF Environmental, Safety, and Occupational Health Need 95-530, Recycling and Verification of Hydraulic Fluid for Reuse). In response, AFRL/MLQ began a hydraulic fluid purification project.

Researchers chose to evaluate a portable hydraulic fluid purifier manufactured by Pall Aeropower Corporation. The Pall purification equipment was selected because it uses a vacuum dehydration, spinning disc process to remove water, air, and volatile organic solvents. It does not use desiccants, heat distillation, or high vacuum that could break down the properties of the base oil. It also incorporates a filtration system to remove particulate matter.

Initial testing revealed the PALL Purifier did not cause any adverse effects on the hydraulic fluid. However, continued testing was needed to evaluate the impact of using purified fluid in aircraft hydraulic pumps. The following text provides information on the testing to date.

INITIAL EVALUATION

In 1995, AFRL/MLQ evaluated the Pall purifier at Tyndall AFB, in an environmentally controlled facility. New hydraulic fluids from Velsicol Chemical Corporation, Castrol Specialty Products Division, and Royal Lubricants, and used hydraulic fluid from Moody AFB, Eglin AFB,

and Dover AFB were evaluated. Each of the new hydraulic fluids was deliberately contaminated with measured amounts of deionized water (1200 ppm) and one gram of AC fine test dust (particulate) at hourly intervals. The Pall purifier was operated for a total of 18.5 hours, for each of the six hydraulic fluids evaluated. Three hydraulic fluid samples were collected from each of the fluids which included: unpurified (baseline), after 8 hours, and after 18.5 hours. The fluid samples were analyzed for degradation at the Materials Engineering Branch (MLSE) of AFRL, Wright-Patterson AFB, OH, in accordance with Military Specification MIL-H-83282C. The fluid was analyzed for viscosity, acid number, rubber swell, water content, lubricity (four-ball wear), evaporation, and oxidation-corrosion. The initial evaluation indicated that the Pall purifier did not degrade the fluids processed.

Based on these encouraging results, AFRL/MLSE recommended that wear testing be accomplished on aircraft hydraulic fluid pumps to determine the impact of fluid purification on pump life/performance. The F-16 emergency power unit (EPU) pump and the main hydraulic fluid pump were selected for these tests because they are common aircraft piston pumps and could be mounted on the test equipment. The Nonstructural Materials Branch (MLBT) of AFRL at Wright-Patterson AFB, OH was tasked to accomplish the tests.

PUMP WEAR TEST #1

The first pump wear test, sponsored by the B-2 Program Office, compared pump wear between two F-16 EPU pumps, operated under load, with both purified and unpurified MIL-H-5606F hydraulic fluid. The two pumps were operated for 1500 hours, each at 3000 psig, with flow rates cycled between 12 gpm and 3 gpm every minute. Each pump was then disassembled and inspected for wear. During the tests, fluid samples were extracted and evaluated for viscosity, water content, lubricity, foaming, metal content, and particle count. At the conclusion of the tests, there was no apparent difference in pump performance and no significant difference between fluid properties, with either purified or unpurified fluid. However, it was noted that there was an equal viscosity change in both the purified and unpurified fluids, which was attributed to the behavior of MIL-H-5606F hydraulic fluid and not the purification process. Again, the results encouraged further testing, this time with MIL-H-83282C hydraulic fluid.

PUMP WEAR TEST #2

The second pump wear test (in progress) is sponsored by the Ogden Air Logistics Center. The objective is to compare pump wear between aircraft pumps, operated under load, with both purified and unpurified MIL-H-83282C hydraulic fluid. However, each fluid will be intentionally contaminated with measured amounts (300 ppm) of distilled water. The two F-16 main hydraulic pumps will be operated for 2000 hours each, at 3100 psig, with flow rates cycled between 28 gpm and 6 gpm every minute. During the tests, fluid samples will be extracted and evaluated for viscosity, water content, lubricity, foaming, metal content, and particle count. Each pump will be disassembled and inspected for wear after 1000 hours and at test termination or 2000 hours, whichever comes first. The first phase of this test using new hydraulic fluid began 4 Feb 98 and was terminated after 1262 hours because a temperature spike in the case drain flow caused an automatic shutdown of the equipment. Pump teardown revealed spalling on the inner race of the roller bearing and the rollers. Excessive wear was also observed on the outer diameter of the cylinder block. Preparations for the second phase of this test are underway using purified hydraulic fluid. The estimated completion date is

December 1998.

OPERATIONAL UTILITY EVALUATION

Headquarters Air Mobility Command (HQ AMC) is currently conducting an operational utility evaluation at McChord AFB, WA on a purifier provided by Pall Aeropower Corporation. This purifier incorporates a state-of-the-art water sensor that automatically shuts off the equipment after a preset level of cleanliness has been reached. HQ AMC plans to determine if the purifier is capable of sufficiently cleaning hydraulic fluid without degrading fluid characteristics and determine if the purifier is logistically supportable. This will be accomplished by purifying new MIL-H-5606, MIL-H-83282, and MIL-H-87257 that has been contaminated with measured amounts of AC fine test dust, deionized water, and PD-680 (solvent). They will also validate procedures to connect the Pall unit to a portable hydraulic test stand, an in-shop hydraulic test stand, and C-141 aircraft hydraulic systems. The estimated completion date is September 1998.

CONCLUSION

It is widely recognized that water and particulate contamination can degrade critical physical properties of hydraulic fluid, impair pump performance, and cause premature failure of the pump. By removing the water and particulates through filtration and purification, users can reuse the hydraulic fluid. The results of the initial evaluation and Pump Wear Test #1 should encourage consumers of large quantities of hydraulic fluid to consider purifying contaminated hydraulic fluid for reuse instead of immediate disposal. **Note:** Hydraulic fluid contaminated with other oils or fuel cannot be purified and reused through this process because it will not separate them.

Commands and Air Logistics Centers wanting to save money could benefit by extending the service life of hydraulic fluid without degrading the fluid's working properties. The average Air Force base can expect to invest less than $50K to reap full benefits of this process, which can be expected to reduce waste hydraulic fluid by 75 percent. The estimated annual Air Force savings of $30 million from use of this process can be multiplied several times, if the process is extended to the Department of Defense and the private sector. This is a truly transferable technology.

It should be noted that the U.S. Army has approved the use of purified MIL-H-46170 and MIL-H-6083 hydraulic fluid in their ground systems. For further information contact Mr. Ralph B. Mowery, AMSTA-TR-D/210, U.S. Army Tank Automotive & Armaments Command, Warren, MI 48937-5000. His telephone number is (810) 574-4220.

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